Croatian Journal of Education
Vol.17; Sp.Ed.No.4/2015, pages: 175-197
Preliminary communication
Paper submitted: 18th February 2013
Paper accepted: 26th October 2015
doi: 10.15516/cje.v17i0.785

Investigating the Effect of Inquiry-Based Learning on Pre-Service Teachers' Attitudes and Opinions about the Approach

Orçun Bozkurt
Faculty of Education, Mustafa Kemal University

Abstract

Aim of the study was to examine the effect of research-based learning on pre-service teachers' attitudes and to present their opinions about the approach in the science and technology laboratory. The study was carried out on 66 undergraduate students, and had the pre-test – post-test control group design. Attitude scale towards the science and technology laboratory, attitude scale towards research-based learning and a form of interview about T diagram used in the research-based learning method were used for data collection. The research-based learning approach was applied in the experimental group, and the traditional learning approach was applied in the control group. The results showed that research-based learning positively affected the students' attitudes towards this and inquiry-based learning approach attitude marks.

Key words: *inquiry-based learning approach; science education; students' attitudes; student opinion.*

Introduction

In the era in which knowledge is increasingly incremental, aim is not to transfer knowledge to learners but to make them understand, and to synthesize the prior knowledge with the new knowledge. Individuals must acquire higher-order skills to reach this aim. Such skills can be acquired foremost in a science lesson.

Science is the systematic analysis of the nature and natural phenomena as well as the effort of predicting unobservable events. Furthermore, science is the product of human endeavours to understand the nature, and consists of phenomena, concepts, generalizations, principles, theories and natural laws (Doğru & Kıyıcı, 2005, p. 2). Abstract concepts are largely included in science and technology education, and children have difficulties when learning them, but it is obligatory and vital to make science more understandable for the education of science and technology because a student is not expected to explain a scientific phenomenon and to have enough knowledge to do so (Dagher, 1995).

Quality education must always be considered important for the contribution of young individuals to the country; as they will dominate the future, they should be raised under suitable conditions. Individuals should be educated not only for today's conditions and should be adorned with the point of view which can take the lead of the future. This can be achieved by raising individuals within such an education system which enables them to search, analyze and find solutions (Bektaş, 2000).

The aim of science education is to put the teacher-centred education aside and to raise inquisitive and creative individuals who learn about the methods of acquiring knowledge and develop the skills of analysis and synthesis, and who can demonstrate the skills of bringing what they learnt into their social and personal life.

Science includes the process of research by its nature. Each individual constructs this process especially for himself/herself. Two different individuals may not comprehend the same concept with the same method. For this reason, they can confirm the phenomenon that they did conceive through research. Research-based learning enables the teacher and students to evaluate the evidence they obtained to study the nature and test their perceptions (Alouf & Bentley, 2003).

Students accept ideas as their own through confirming or disconfirming them. Therefore, if a wrong idea of any student is to be discarded, a concrete experience which is likely to lead to logical results and elimination of the previous misconception should be provided (Sardilli, 1998).

If the units of science are presented to students as the piles of knowledge, then it will not be possible for them to develop their skills of research and problem-solving. In other words, those with little or no research experience have difficulties in developing a hypothesis, and plan to obtain their own ideas through discussing the ideas of other people and evaluating their knowledge. Research-based learning, which was emphasized by the American National Science Education Standards, is very effective in making up the shortage (Trumbull et al., 2005).

The student who actively participates in learning ensures this process to be more permanent via learning based on research and scrutiny and, at the same time, acquires the skills of problem-solving and right decision-making. If research-based learning is experienced very often, self-learning or learning about how to learn will improve by itself (Gardner, Demirtaş, & Doğanay, 1997). The individuals, who learn how to learn, develop productive skills of critical thinking, creative thinking, and reflective thinking. The knowledge and skills acquired with the help of research-based learning are some of the basic components of individuals in a democratic society (Demircioğlu, 2005, p. 165).

In research-based learning, students are not passive like the ones in the traditional classroom. Students are active at every stage of the research process. They take the responsibility which is necessary for their learning by searching and finding answers to questions. They find concepts, they can tell how they reached their goals and how they learnt contents, and they specialize in this area (Alvarado & Herr, 2003, p. 23).

What students know about a science education lesson is not important, but what they feel is much more important. If students have positive feelings and good experiences about the science education lesson at the beginning, they will probably be successful regarding their future science-related experiences. This will make them gain positive attitudes towards science, they will be interested in science and have pleasure in learning science. In contrast, if students cannot have enough support and have negative experiences at the very beginning of science education lessons, they will hang back from science education lessons for the rest of their lives. As a result, they will lack sufficient knowledge of science education and they will have negative attitudes towards these lessons (Ebenezer & Zoller, 1993).

Before having an attitude towards science, it is necessary for students to know what science is. With no knowledge of this kind and with wrong ideas they hear from people around them, students may develop a negative attitude. Little children do not have enough experience to shape their ideas and attitudes to science and scientific activities, so they will not be influenced by the wrong ideas of other people if they have science education lessons which have plenty of research activities (Harlen, 1998).

Alvarado and Herr (2003, p. 8) stated that students acquire important knowledge when they actively search for topics in which they are interested and motivated. Firstly, their motivation increases; secondly, they understand better. In addition, they can make deeper connections with their knowledge. Thirdly, they learn about the basic concepts and the research process very well by searching alternative explanations of the questions they prepared. We can sum up the benefits of research-based learning in education and teaching process (Alvarado & Herr, 2003, pp. 22-23; Lim, 2001, p. 29).

In the light of all this knowledge, the aim of the current study is to identify students' ideas about the traditional approach and to determine the effect of the so-called approach and research-based learning (in science education for pre-service classroom teachers) on students' attitudes towards science.

Aim of the Study

The aim of the study was to analyze the effects of research-based learning and traditional learning (in science education for pre-service classroom teachers) on students' attitudes to the science and technology laboratory, as well as their attitudes and opinions about the research–based type of learning.

Research Questions

1. Is there a significant difference in the attitudes of the students (taught with research-based learning and teacher-centred methods in science education) towards the science and technology laboratory?
2. What are the students' attitudes towards research-based learning in science education?

3. What are the students' opinions about T diagram, which is used for research-based learning?

Importance of the Study

To make science and technology education more productive, it is necessary for students to perform their learning by searching, questioning and following the scientific process.

This study will contribute to the literature on science education and will help teachers to select as preferred this particular approach– which must be used very often in the renewed primary education programme – in their teaching.

This study includes information about classroom environment, structure of the education programme, roles of teachers and students, and about how courses (with research-based learning) will be structured. This study will contribute to the literature in terms of scientific process skills used by students and their improvements.

Therefore, we can say that this study, corresponding to the philosophy and learning/ teaching methods on which the new programme is based, will shed light for educators who want to increase the quality of their teaching.

Method

In the research model, the number of groups participating in the experiment, time and number of observations made on control measures and independent variable were considered; the research model is a quasi-experimental method with pre-test and post-test control group with high acceptance (Campbell & Stanley, 1996).

The experimental design used in the research and the independent variable whose effect was analyzed on the experimental group is research-based learning approach. In the control group, an approach based on traditional teaching was followed. Comparison was made between the groups by using pre-test and post-test scores of the scale of attitudes towards science and technology lessons, which is a dependent variable in both groups. At the same time, the scale of attitudes towards the method and student interview forms were used in the experimental group.

Table 1

Pre-test - post-test application in control group design

Group	Pre-test	Process	Post- test
Experimental	ASTSTL	Research-based Learning	ASTSTL Interview Form ASTRBL
Control	ASTSTL	Traditional Method	ASTSTL

Population and Sample

The study was conducted in two different classes of the Primary Teacher Training Department, Faculty of Education, Mustafa Kemal University. Experimental and control groups were randomly selected. Sixty-six students participated in this study and the lessons were delivered by the researcher.

Process of Application

In the experimental group, the research-based method was used for presenting the unit of material exchange in cells, while the traditional method was used in the control group.

The study application process lasted for 8 weeks in both groups. The data obtained from the pre-test and post-test was analyzed with the required statistical operations.

Data Collection Tools

Attitude Scale towards Science and Technology Laboratory (ASTSTL)

In order to determine students' attitudes towards the science and technology course, the Attitude Scale towards Science and Technology Laboratory was used (ASTSTL).

The scale, used in the research for the same purpose, was applied by İnce et al. (2007) before and after the study with experimental and control groups. The reliability of the scale was found to be 0.80 in pilot studies.

The scale is in the form of Likert-type measurement tool. Some of the items in the questionnaire are positive, and some of them are negative. For every item, the following options are given: "I totally agree", "I agree", "I am indecisive", "I disagree", and "I totally disagree". The results are evaluated by giving 5,4,3,2,1 for the positive answers, and 1,2,3,4,5 for the negative answers. The questionnaire was applied as a pre-test and post-test instrument with the members of each group and 30 minutes were available for administering this scale.

Attitude Scale towards Research-Based Learning (ASTRBL)

A 3-point Likert-type rating scale (25 items) was prepared for the purpose of determining the opinions of the students about inquiry-based learning and T diagram. The scale was developed by Samancı and Bozkurt (2010). The items in the scale were gathered under two groups: the effects of a T diagram on developing the skills of scientific process and the evaluation of inquiry-based learning environment, which is constituted by means of a T diagram. The coefficient alpha reliability of Cronbach scale was found to be $\alpha=.73$

Interview Form towards T Diagram Used in the Research-Based Learning Method

Semi-structured interview was used to determine the students' opinions about a T diagram used in research-based learning. The following open-ended questions were asked in the interview form:

1. What are the advantages of a T diagram over the traditional laboratory report?
2. What are the disadvantages of a T diagram over the traditional laboratory report?
3. Which parts of a T diagram are unnecessary in your opinion?

Data Analysis

In this study, independent samples t- test was applied to clarify whether or not there was a difference in terms of their attitudes towards the science and technology course between the experimental group taught with the research-based method and the control group taught with the traditional method. The significant difference in 95% frequency of reliability was considered between the scores of both groups. Independent variable analysed on the experimental group was "Inquiry Based Learning Approach". On the other hand, "Traditional Method Approach" was applied with the control group.

As a result of this analysis, the matter of whether both groups were equivalent was then considered by taking into account arithmetic means (X), standard deviations (SD), t-values and significance levels (p).

Percentage (%) and frequency (f) tables were constructed for the item distribution regarding the analysis of the attitude scale towards research-based learning method.

Starting from the content analysis for the purpose of evaluating the interview responses about T diagram used in research-based learning, the opinions with regard to the three questions were put forward, and then percentage and frequency tables were also created.

Findings and Comments

Under the first sub-problem of the study, the attitudes of the students taught with the research-based method were compared to those of the students taught with the traditional method. The difference between the experimental and the control group in terms of their ASTSTL pre-test scores can be seen in Table 2.

Table 2

T-test results of independent groups related to the ASTSTL pre-test score of students in the experimental and control group

ASTSTL	GROUP	N	X	SD	t	f	p
Pre-test	Experimental	33	63.480	5.083	.835	64	.408*
	Control	33	62.480	3.163			

N: 66, * 0.408> 0.05, ASTSTL: Attitude Scale towards Science and Technology Laboratory

As presented in Table 2, there was no significant difference between the ASTSTL pre-test scores of the students in the experimental and the control group ($t(64)= .835$, $p>0.05$). Before the experimental study, no difference showed that the groups were equivalent in terms of their attitude.

Table 3

T-test results of independent groups related to the ASTSTL post-test score of students in the experimental and control group

ASTSTL	GROUP	N	X	SD	t	df	p
Post-test	Experimental	33	83.720	6.605	3.523	64	0.001*
	Control	33	77.720	5.373			

N: 66, * 0.001< 0.05, ASTSTL: Attitude Scale towards Science and Technology Laboratory

According to data presented in Table 3, the ASTSTL score average of the students in the experimental group was higher after the experimental study. The difference between the two groups was statistically significant ($t(64)= 3.523, p<0.005$), which may have resulted from the independent variable, i.e. from the method itself. In this context, research-based learning affected the students' attitudes towards science and technology laboratory in a positive way.

The attitudes towards the research-based learning method in the experimental group were determined under the second sub-problem of the study. In this context, the frequency and percentage data regarding the T diagram sub-dimension of measuring the attitude scores are given in Table 4.

Table 4

Attitudes of the experimental group members towards T diagram in the research-based learning method

No	Statements	A		NS		DA	
		f	%	f	%	f	%
1.	TD makes us research detailed pre-information related with the unit.	24	72.7	7	21.2	2	6.1
2.	TD develops our skill of scientific thinking.	27	81.8	3	9.1	3	9.1
3.	TD develops our skill of data analysis and making comments.	28	84.8	4	12.1	1	3
4.	TD enables us to gain first-hand experience related with the process of acquiring knowledge.	20	60.6	8	24.2	5	15.2
5.	TD provides guidelines for putting scientific process into practice.	26	78.8	5	15.2	2	6.1
6.	TD develops our problem-solving skills.	28	84.8	5	15.2	0	0
7.	TD provides permanent learning and significant learning.	27	81.8	4	12.1	2	6.1
8.	TD requires us to create tables and graphics related with the experiment.	27	81.8	4	12.1	2	6.1
9.	TD provides the opportunity to learn by doing and experiencing.	29	87.9	3	9.1	1	3
10.	TD gives us the opportunity to bring what we learn to daily life.	0	0	5	15.2	28	84.8
11.	TD contributes to the development of experimenting skill.	28	84.8	3	9.1	2	6.1
12.	TD provides the skill of questioning phenomena, concepts or events in contrast to experiments such as recipes.	30	90.9	3	9.1	0	0
13.	TD is a good means of evaluation.	20	60.6	13	39.4	0	0
14.	TD develops our skills of creative and critical thinking.	23	69.7	8	24.2	2	6.1

(A=I agree, NS= I am not sure, DA= I disagree)

When we look at "TD enables us to acquire the skill of questioning phenomena, concepts or events in contrast to experiments such as recipes", we can see that this item was the most agreed with (90.0%). Additionally, except for "TD gives us the opportunity to bring what we learn to life", the other items were agreed with at a high percentage (20% - 90.9%). In this respect, the students' attitudes towards T diagram can be said to be positive.

The second sub-scale data referring to the attitudes towards the research-based learning method within the experimental group are given in Table 5.

Table 5

Attitudes of the experimental group members towards the research-based learning method

No	Statements	A		NS		DA	
		f	%	f	%	f	%
15.	RBL requires much effort and time.	26	78.8	5	15.2	2	6.1
16.	RBL enables us to approach the subject from a broader perspective.	32	97	0	0	1	3.0
17.	RBL provides an effective and active learning environment.	30	90.9	3	9.1	0	0
18.	RBL appeals to students with different learning skills.	18	54.4	11	33.3	4	12.1
19.	RBL encourages group work.	21	63.6	8	24.2	4	12.1
20.	RBL enables us to get higher marks.	13	39.4	13	39.4	7	21.2
21.	RBL increases the student-teacher interaction.	21	63.6	6	18.2	6	18.2
22.	RBL increases my interest in a lesson.	27	81.8	5	15.2	1	3
23.	RBL enables us to come to the class well-prepared.	29	87.9	3	9.1	1	3.0
24.	RBL encourages the desire to doing research.	26	78.8	5	15.2	2	6.1
25.	RBL enables us to see alternative experiments in case of the same lesson.	29	87.9	4	12.1	0	0

(A=I agree, NS= I am not sure, DA= I disagree)

According to Table 5, we can see that the item with which the students agreed the most was "RBL provides an effective and active learning environment" (90.9%). The item with which they agreed the least was "RBL enables us to get higher marks" (39.4%). So, the students' attitudes were positive in general and the percentage changed from 39.4 to 90.9.

An attempt was made to determine the students' attitudes towards T diagram used in research-based learning under the third sub-problem of the study. The opinions regarding "the advantages of a T diagram over the traditional laboratory report" are given in Table 6, along with percentages and frequencies.

In Table 6 the students expressed their opinions about the advantages of a T diagram especially for these items: "develops the skill of conducting the scientific process", "experiments are brought to daily life", and "enables us to know the drill".

Additionally, 3 students expressed their opinions about the advantages of a T diagram with regard to "its variables are controllable", while 2 students chose "reduces the number of experimental mistakes."

Table 6

Analysis of advantages frequencies - the T diagram versus the traditional laboratory report

JUDGEMENT		f	%
1	Makes students active.	9	27
2	Develops creativity.	8	24
3	Reduces the number of experimental mistakes.	2	6
4	Develops the students' skill of doing research.	7	21
5	Develops the skill of conducting the scientific process.	17	51
6	Provides the concretization of experiments.	2	6
7	Directs us to thinking.	6	18
8	Enables us to know the drill.	13	39
9	Makes learning easier.	10	30
10	Provides permanent learning.	12	36
11	Experiments are brought to daily life.	13	39
12	Arouses curiosity.	4	12
13	Helps us acquire new knowledge.	8	24
14	Provides the cause and result relation.	4	12
15	Develops the feeling of responsibility.	5	15
16	Is more clear, simple and understandable.	5	15
17	Its variables are controllable.	3	9

The students' opinions about the disadvantages of a T diagram over the traditional laboratory report are given in Table 7.

Table 7

Analysis of disadvantages frequencies - the T diagram via the traditional laboratory report

JUDGEMENT		**f**	**%**
1	Its use is time-consuming.	17	51
2	Many details in the diagram.	11	33
3	Boring.	9	27
4	Reduces the curiosity for experiment.	2	6
5	Difficult to put into practice.	7	21
6	Difficult to get used to.	3	9
7	Based on multi-information.	6	18
8	The chance of error-correction is low.	5	15
9	Full of repetitions.	1	3
10	Restricts the topic.	3	9
11	Requires much attention.	3	9
12	May not be applied to every level.	5	15

Table 7 particularly reveals the following opinions about the disadvantages of a T diagram over the traditional laboratory report: "its use is time-consuming", "many details in the diagram", "boring" and "difficult to put into practice". The least-stated opinions were "requires much attention" and "may not be applied to every level"

What the students considered unnecessary is given in Table 8.

Table 8

Frequency analysis of the T diagram titles believed to be unnecessary

	JUDGEMENT	f	%
1	"New knowledge" must be removed.	3	9
2	"Why" question must be removed.	2	6
3	"Dependent and independent variable" must be removed.	2	6
4	"Prior knowledge" must be removed.	4	12
5	"Possible experiment mistakes" must be removed.	3	9
6	"Fixed variable" must be removed.	3	9
7	"Limitations" must be removed.	2	6
8	"Cause-Effect" must be removed.	1	3
9	"Scientific claim" must be removed.	2	6

According to Table 8, 4 students stated that "prior knowledge" was unnecessary, 3 students considered "possible experimental mistakes" unnecessary, and 3 students chose "fixed variable" for this purpose. In this context, some of the items were found to be unnecessary, regardless of their low rate (12% and 9%).

Results and Conclusions

Speaking about the first sub-problem of the study, it can be seen that research-based learning – when compared to the traditional approach – makes a positive significant difference in the attitudes towards the science and technology laboratory, stated by the pre-service primary education teachers. Additionally, this result is in parallel with the studies described in the relevant literature by Shymansky et al. (1983), Kyle et al. (1985), Germann (1994), Freedman (1997) and Orcutt (1997). Suchman (1968) stated the following definition: "Research is the science itself rather than the method of science" (cited by Zion et al., 2004; p. 728). So, research-based learning offers us an opportunity to interpret science and take active part in this process since it is in the nature of science. The process of learning and teaching – the activities done in the science laboratory – affects students' attitudes. It affects them directly in terms of their active participation in the process and suggestion of ideas. According to Wallace (1997), research-based learning completely handles concepts, values, educational practices and beliefs based on the attitudes that students develop during their active science study.

As for the attitudes towards research-based learning under the second sub-problem of the research, it is clear that the percentage of pre-service teachers' attitude scores regarding T diagram and the method were high, in 20 and 90.9% frequency. In this context, we see that the method made a positive effect on the students; in particular, the items of "providing active learning", "examining the skill of questioning", "establishing cause and effect relation" were preferred with a high frequency. According to Wallace (1997), research-based learning is a set of concepts, values, educational practices and beliefs based on the attitudes that students develop during their active science study. Llewellyn (2002) states that research gives students an opportunity to face with a problem and find ideas by themselves to solve the problem. When students are taught according to the research method, they find their results and evaluate them through applying their thoughts and beliefs to new problems. According to Chiappetta et al. (1998), research – in science education – is used as an active process which includes scientific thinking, questioning and structuring of knowledge (cited by Domjan, 2003). Besides, it has a direct effect on the development of pre-service teachers' positive attitudes towards research-based learning, and results of the studies conducted by Germann (1994) and Freedman (1997) support this.

Considering the students' opinions about the advantages of using a T diagram, we can notice that they expressed their opinions, such as: "experiments are brought to daily life", "enables us to know the drill", "develops the skill of conducting the scientific process". The items of "directs us to thinking", "permanent learning" were also mentioned as the advantages. Science education lessons taught with the research-based learning method are the most appropriate lessons for students' experiential generalisations. Students develop their skills necessary to use the knowledge they possess and they have acquired. Therefore, they can use their skills even after their formal education (Plowright & Watkins, 2004). In this respect, a T diagram is important in terms of making students acquire the skills of "thinking actively during the process" and "permanent learning". According to Wilke and Straits (2005), research-based learning draws attention to important variables, it also prevents misconceptions by being active in structuring an answer instead of providing a simple definition. T diagram – the process of reporting on research-based learning – is structured in such a pattern as to take into account the control of variables, concept clarifications and multi-learning interaction.

With regard to the disadvantages of a T diagram stated by the pre-service teachers, we can say that these stem from their perception of its use as time-consuming, detailed and difficult. Büyükkaragöz and Çivi (1999) also emphasize that research-based learning is efficient for developing the higher-order mental processes and cognitive behaviours, such as application, analysis, synthesis and evaluation. However, students – prior to this stage – should reach at least the comprehension level.

If practitioners cannot make students "learn at the comprehension level", it is normal for students to experience difficulties in the process. The students stated that the items of "why" and "new knowledge" should be removed from a T diagram. Such an overview should be considered: practitioners fail to fully explain how new knowledge can be used to learn and solve different problems and they may cause difficulties in establishing a relationship.

These suggestions can be offered according to the results of the study:

1. In order to raise individuals of scientific thinking who know how to use the science laboratory, teachers should apply creative and inquisitive methods which explain how knowledge may be acquired, not the teacher-centred traditional method.
2. Teachers should make use of time well while teaching by the research-based method, so they should come to school well prepared and plan the lesson very carefully.
3. At the beginning, students must be informed about the T diagram, which can be used in the process of reporting and they should avoid focusing on irrelevant details.
4. Students should be enabled to acquire the necessary prior knowledge and skills at the comprehension level in order not to have difficulty when creating and using the T diagram.
5. The effect of research-based learning skills and self-learning skills can be considered.
6. This study included pre-service primary education teachers, but it can also include pre-service science education teachers or secondary education students.

References

Alouf, L. J., & Bentley M. L. (2003). *Assessing the Impact of Inquiry-Based Science Teaching in Professional Development Activities, PK-12.* A Paper Presented at the 2003 Annual Meeting of the Association of Teacher Educators.

Alvarado, E. A., & Herr P. H. (2003). *Inquiry-Based Learning: Using Everyday Objects*. California: Corwin Pres, Inc.

Bektaş, I. (2000). *Developing Guide Materials About Transport and Circulatory System in Biology Instruction*. Unpublished Master's Thesis. Trabzon: Institute of Science Karadeniz Technical University.

Büyükkaragöz, S., & Çivi C. (1999). *General Teaching Methods.* İstanbul: Beta Publishing.

Campbell, D. T., & Stanley, J. C. (1996). E*xperimental and Quasi-Experimental Designs for Research*. Chicago: Rand McNally College Publishing Company.

Chiappetta, L. E. (1998). Inquiry-Based Science: Strategies and Techniques for Encouraging Inquiry in the Classroom. *The Science Teacher*, *64*(7), 22-26.

Dagher, Z. R. (1995). Analysis of Analogies Used by Science Teachers. *Journal of Research in Science Teaching*, *32*, 259–270. http://dx.doi.org/10.1002/tea.3660320306

Demircioğlu, İ. H. (2005). Teaching Strategies. In C. Öztürk, & D. Dilek (Eds.), *Life Science and Social Studies Teaching.* Ankara: Pegem A Publishing.

Doğru, M., & Kıyıcı, F. B. (2005). Necessity of Science Education. In M. Aydoğdu, & T. Kesercioğlu (Eds.), *Science and Technology Education in Primary Education* (pp. 1-8). *Ankara: Anı Publishing.*

Domjan, N. H. (2003). *An Analysis of Elementary Teachers' Perceptions of Teaching Science as Inquiry.* Unpublished Doctoral Dissertation. Houston: University of Houston.

Ebenezer, V. J., & Uri, Z. (1993). Grade 10 Students' Perceptions of and Attitudes Toward Science Teaching and School Science. *Journal of Research in Science Teaching*, *30*(2), 175-186. http://dx.doi.org/10.1002/tea.3660300205

Freedman P. M. (1997). Relationship Among Laboratory Instruction, Attitude Toward Science, and Achievement in Science Knowledge. *Journal of Research in Science Teaching*, *34*(4), 343-357. http://dx.doi.org/10.1002/(SICI)1098-2736(199704)34:4<343::AID-TEA5>3.0.CO;2-R

Gardner, W., Demirtaş, A., & Doğanay, A. (1997). *Social Studies Education.* Ankara: YÖK/World Bank, National Education Development Project. Pre-Service Teacher Education, Section: 4, 15-16.

Germann, J. P. (1994). Testing a Model of Science Process Skills Acquisition: An Interaction with Parents' Education, Preferred Language, Gender, Science Attitude, Cognitive Development, Academic Ability and Biology Knowledge. *Journal of Research in Science Teaching*, *31*(7), 749-783. http://dx.doi.org/10.1002/tea.3660310707

Harlen, W. (1998). *The Teaching of Science in Primary Schools*. Trowbridge: The Cromwell Press.

İnce, E., Güven, E., & Sertçıbık, A. (2007). Candidates of Science and Social Studies Teachers' Attitudes Towards of Science and Laboratory. *I. National Primary Congress* (pp. 457-466). Ankara: Faculty of Education University of Hacettepe.

Kyle, C. W., Ronald, J. B., Mcclsokey, S., & Fults, B. A. (1985). Science Through Discovery: Students Love It. *Science and Children*, *23*, 39-41.

Lım, B. (2001). *Guidelines for Designing Inquiry-Based Learning on the Web: Online Professional Development of Educator.* Unpublished Doctoral Dissertation. Bloomington: University of Indiana.

Llewellyn, D. (2002). *Inquiry Within: Implementing Inquiry-Based Science Standards*. California: Corwin Press.

Orcutt, C. B. J. (1997*). A Case Study on Inquiry-Based Science Education and Students' Feelings of Success.* Unpublished Masters' Thesis. California: University of San Jose State.

Plowright, D., & Watkins, M. (2004). There Are No Problems to Be Solved, Only Inquiries to Be Made, in Social Work Education. *Innovations in Education and Teaching International*, *41*(2), 185-206. http://dx.doi.org/10.1080/1470329042000208701

Samancı, N. K., & Bozkurt, O. (2010). An Alternative Tool for Inquiry Based Learning: "T" Diagram. *World Applied Sciences Journal*, 9(4), 385-392.

Sardilli, S. L. (1998). The Use of a Web Site to Disperse Information on Discovery-Based Learning in Elementary Science Education. *Marist College.* (ERIC Document Reproduction Service No. ED 436 365).

Shymansky, J. A., Kyle, W. C., & Alport, J. M. (1983). The Effects of New Science Curricula on Student Performance. *Journal of Research in Science Teaching, 20*(5), 387-404. http://dx.doi.org/10.1002/tea.3660200504

Trumbull, J. D., Bonne, R., & Schuck, N. G. (2005). Developing Materials to Promote Inquiry: Lessons Learned. *Science Education*, 89(6), 879-900. http://dx.doi.org/10.1002/sce.20081

Wallace, R. S. (1997). *Structural Equation Model of the Relationships Among Inquiry-Based Instruction, Attitudes Toward Science, Achievement in Science, and Gender*. Unpublished Doctoral Dissertation. Dekalb: University of Northern Illinois.

Wilke, R. R., & Straits, W. J. (2005). Practical Advice for Teaching Inquiry-Based Science Process Skills in the Biological Sciences. *The American Biology Teacher, 67*(9), 534-540. http://dx.doi.org/10.1662/0002-7685(2005)067[0534:PAFTIS]2.0.CO;2

Zıon, M. et al. (2004). Dynamic, Open Inquiry in Biology Learning. *Science Education, 88*(5), 728-753. http://dx.doi.org/10.1002/sce.10145

Orçun Bozkurt
Faculty of Education
Mustafa Kemal University
31040 Antakya, Hatay, Turkey
orcunbozkurt@gmail.com

Istraživanje utjecaja istraživačkog pristupa učenju na stavove i mišljenja budućih nastavnika o njemu

Sažetak

Cilj je istraživanja bio odrediti utjecaj istraživačkog pristupa učenju na stavove budućih nastavnika i predstaviti njihova mišljenja o istraživačkom pristupu u laboratoriju za istraživački rad. U njemu je sudjelovalo ukupno 66 dodiplomskih studenata, a obuhvaćalo je pred-testiranje i post-testiranje kontrolne grupe. Za prikupljanje podataka korišteni su: ljestvica stavova o laboratoriju, ljestvica stavova o istraživačkom učenju i intervju o T dijagramu koji se koristi u istraživačkoj nastavi. Istraživački se pristup odnosio na eksperimentalnu grupu, dok se tradicionalni pristup odnosio na kontrolnu grupu. Prema rezultatu istraživanja, istraživačka je nastava pozitivno utjecala na stavove studenata o njoj.

Ključne riječi: *istraživački pristup učenju; nastava prirodoslovlja; stavovi studenata; mišljenja studenata*

Uvod

U doba kada se znanje intenzivno mijenja učenicima nije bitno samo prenijeti ga, već im pomoći kako razumjeti ono što već znaju i to povezati s novim spoznajama, a da bi se individualno razvijali moraju usvojiti složenije vještine u skladu s tim ciljem. To je moguće postići u nastavi prirodoslovlja.

Prirodoslovlje predstavlja sustavnu analizu prirode i fenomena u prirodi; također nastoji predvidjeti one fenomene koji se ne mogu zapažati. Proizvod je čovjekovih nastojanja da shvati prirodu, a obuhvaća pojave, koncepte, opće zaključke, načela, teorije i prirodne zakone (Doğru i Kıyıcı, 2005, str. 2). Apstraktne ideje u velikoj mjeri pripadaju znanstveno-tehnološkom obrazovanju i djeca ih teško usvajaju. No, potrebno je, čak ključno, učenicima učiniti znanost razumljivijom kada je riječ o toj vrsti obrazovanja jer se od njih ne očekuje da objašnjavaju neki fenomen, odnosno da imaju dovoljno znanja da bi ga objasnili (Dagher, 1995).

Kvalitetno se obrazovanje nužno smatra važnim zbog doprinosa koje mladi ljudi daju svojoj zemlji, stoga ih, s obzirom da će imati vodeću ulogu u budućnosti, treba obrazovati u odgovarajućim uvjetima. Potrebno ih je obrazovati ne samo u skladu s današnjim okolnostima nego također u skladu sa stajalištima koja će možda prevladavati u budućnosti, a to je pak moguće postići u obrazovnom sustavu u kojem su učenici slobodni istraživati, analizirati i tražiti rješenja (Bektaş, 2000).

Cilj nastave prirodoslovlja nije osigurati nastavniku središnju ulogu, već obrazovati znatiželjne i kreativne pojedince koji uče kako učiti i razvijati sposobnost analize i sinteze, koji mogu pokazati da znanje kojim raspolažu primjenjuju u svom društvenom i privatnom životu.

Znanosti je inherentan istraživački proces, a svaki ga pojedinac stvara za sebe. Dva različita pojedinca možda ne shvaćaju isti koncept na isti način tako da istraživanjem mogu potvrditi postojanje pojave koju su spoznali. Istraživačka nastava omogućuje nastavniku i učenicima vrednovati dokaze do kojih su došli da bi proučavali prirodu i testirali svoje predodžbe (Alouf i Bentley, 2003).

Učenici prihvaćaju ideje kao svoje tako što ih dokazuju ili potvrđuju. Ako želi odbaciti neku svoju pogrešnu ideju, učeniku je potrebno konkretno iskustvo koje će mu omogućiti logične rezultate i eliminirati mu prethodno, pogrešno shvaćanje (Sardilli, 1998).

Ako se nastavne jedinice učenicima prezentiraju kao nagomilano znanje o prirodoslovlju, tada neće moći razviti vještine proučavanja i rješavanja problema. Drugim riječima, učenicima koji raspolažu neznatnim istraživačkim iskustvom ili ga uopće nemaju teško je razviti hipotezu, stoga planiraju do nje doći tako što raspravljaju o idejama drugih i vrednuju njihovo znanje. Istraživačko učenje kojem se pripada osobita uloga u Američkim nacionalnim standardima za nastavu prirodoslovlja vrlo je učinkovito za prevladavanje spomenutog nedostatka (Trumbull i sur., 2005).

Učenik, aktivan u nastavnom procesu, sam sebi osigurava trajnije učenje kroz istraživanje i pažljivo proučavanje, a istodobno razvija vještine rješavanja problema i donošenja pravilnih odluka. Ako se istraživačko učenje vrlo često primjenjuje, tada će se samoučenje ili učenje o tome kako učiti poboljšati samo po sebi (Gardner, Demirtaş i Doğanay, 1997). Pojedinci koji uče kako učiti fleksibilno i produktivno usvajaju vještine kritičkog mišljenja, kreativnog mišljenja, refleksivnog mišljenja. Znanje i vještine do kojih se dolazi istraživačkim učenjem neke su od temeljnih komponenti pojedinaca u demokratskom društvu (Demircioğlu, 2005, str. 165).

U istraživačkoj nastavi učenici nisu pasivni kao u tradicionalnoj učionici, aktivni su u svakoj fazi istraživačkog procesa i preuzimaju potrebnu odgovornost za učenje tako što sami istražuju, pronalaze odgovore na pitanja. Otkrivaju koncepte, znaju objasniti kako su stigli do cilja i kako su usvojili neki sadržaj, specijaliziraju se za to područje (Alvarado i Herr, 2003, str. 23).

Ono što učenici znaju o nastavnoj jedinici nije važno, ono što osjećaju vrlo je važno. Ako su im na početku nastave prirodoslovlja osjećaji pozitivni, a iskustvo dobro, vjerojatno će s tim imati pozitivno iskustvo u budućnosti. Zbog toga će imati pozitivan stav o prirodoslovlju i ono će ih zanimati, pa će ga učiti sa zadovoljstvom. Međutim, ako ne mogu dobiti dostatnu podršku, a iskustva su im negativna na samom početku, kasnije će se u životu opirati nastavi prirodoslovlja. Stoga će im prirodoslovno znanje biti manjkavo, a stav o nastavi toga predmeta negativan (Ebenezer i Zoller, 1993).

Prije nego zauzmu bilo kakav stav o prirodoslovlju učenici trebaju znati što je prirodoslovlje. Ako to ne znaju, pa raspolažu pogrešnim idejama koje čuju oko sebe, postupno mogu razviti negativan stav. Budući da mala djeca nemaju mnogo iskustva da bi formirala ideje i stavove o prirodoslovlju i prirodoslovnim aktivnostima, na njih neće utjecati pogrešne ideje velikog broja ljudi, pod uvjetom da su itekako izložena istraživačkom radu u nastavi prirodoslovlja (Harlen, 1998).

Alvarado i Herr (2003, str. 8) smatraju da učenici dolaze do važnih spoznaja kada aktivno proučavaju teme koje ih zanimaju i kada su motivirani. Prvo, motivacija im se povećava; drugo, bolje shvaćaju. Osim toga, mogu dublje povezivati novo s postojećim znanjem. Treće, vrlo dobro usvajaju osnovne koncepte i uče o istraživačkom procesu dok traže alternativna objašnjenja za pripremljena pitanja. Možemo sažeti prednosti istraživačkog učenja u nastavi i procesa poučavanja (Alvarado i Herr, 2003, str. 22-23; Lim, 2001, str. 29).

U svjetlu svega ovoga cilj je istraživanja utvrditi što ispitanici misle o tradicionalnom pristupu te odrediti utjecaj takozvanog istraživačkog pristupa učenju (za studente učiteljskog studija) na stavove ispitanika o prirodoslovlju.

Cilj istraživanja

Cilj je istraživanja najprije analizirati utjecaj istraživačkog i tradicionalnog pristupa učenju (u nastavi prirodoslovlja) na stavove ispitanika (studenata učiteljskog studija) o laboratoriju za znanstveno-istraživački rad, a zatim odrediti njihove stavove i mišljenja o istraživačkoj nastavi.

Istraživačka pitanja

1. Postoji li značajna razlika u stavovima ispitanika (poučavani istraživačkim pristupom, frontalnom metodom s nastavnikom u središtu nastave) o znanstveno-tehnološkom laboratoriju?
2. Kakvi su stavovi ispitanika o istraživačkom pristupu nastavi prirodoslovlja?
3. Kakva su mišljenja ispitanika o T dijagramu koji se koristi za istraživačko učenje?

Važnost istraživanja

Da bi se znanstveno-tehnološko obrazovanje učinilo produktivnijim, potrebno je učiti pomoću proučavanja, postavljanja pitanja i praćenja istraživačkog procesa.

Ovo će istraživanje biti prilog literaturi o nastavi prirodoslovlja i upravo će pomoći nastavnicima da se odluče za ovakav pristup – koji se mora primjenjivati vrlo često u novijem programu primarne edukacije.

Ovo istraživanje sadrži podatke o razrednom okruženju, strukturi obrazovnog programa, ulogama nastavnika i učenika, te organizaciji kolegija koji polazi od istraživačkog pristupa nastavi. Dopunit će referentne izvore o tome koje vještine istraživanja u prirodoslovlju koriste učenici i kako ih unapređuju.

U tom kontekstu možemo reći da će ovo istraživanje, provedeno u skladu s filozofijom i nastavnim metodama što ih nalazimo u novom programu, dati pojašnjenje nastavnicima koji žele poboljšati kvalitetu svoje nastave.

Metoda

U ovom se modelu istraživanja razmatraju broj grupa sudionica u eksperimentu, vrijeme promatranja i njihov broj izračunat na temelju kontrolnih mjera i neovisnih varijabli; on pripada kvazi-eksperimentalnoj metodi s pred-testiranjem i post-testiranjem kontrolne grupe s visokim stupnjem očekivanja (Campbell i Stanley, 1996).

Na eksperimentalnu grupu primijenjen je istraživački, a na kontrolnu tradicionalni pristup nastavi. Grupe se uspoređuju na temelju rezultata pred-testiranja i post-testiranja s obzirom na ljestvicu stavova o znanstveno-tehnološkom obrazovanju, što čini ovisnu varijablu u objema grupama. Istodobno se u eksperimentalnoj grupi koristi ljestvica stavova o toj metodi i intervju.

Tablica 1.

Populacija i uzorak

Istraživanje je provedeno u različitim, nasumično izabranim grupama (1 eksperimentalna i 1 kontrolna), na Odsjeku za učiteljske studije Fakulteta za obrazovanje pri Sveučilištu Mustafa Kemal. U njemu je sudjelovalo 66 studenata, a nastavu je održao sam istraživač.

Proces prijavljivanja

U eksperimentalnoj je grupi korištena istraživačka metoda u nastavi o razmijeni staničnog materijala, dok je tradicionalna metoda korištena u kontrolnoj grupi.

Proces prijavljivanja za istraživanje trajao je 8 tjedana u objema grupama. Rezultati postignuti pred-testiranjem i post-testiranjem analizirani su pomoću potrebnih statističkih operacija.

Alati za prikupljanje podataka

Ljestvica stavova o laboratoriju za znanstveno-istraživački rad (LjSZTL)

Da bi se odredili stavovi ispitanika o znanstveno-tehnološkom kolegiju, rabi se ljestvica stavova o znanstveno-tehnološkom laboratoriju (LjSZTL).

Tu ljestvicu, korištenu u ovom istraživanju s istim ciljem, primjenjuju İnce i sur. (2007) prije i poslije istraživanja s eksperimentalnim i kontrolnim grupama. Pouzdanost ljestvice iznosi 0.80 u pilot istraživanjima.

Ljestvica je u obliku mjernog instrumental Likertovog tipa. Neke su čestice pozitivne, a neke su negativne. Za svaku česticu ponuđene su sljedeće mogućnosti: "Potpuno se slažem", "Slažem se", "Neodlučan sam", "Ne slažem se" i "Uopće se ne slažem". Rezultati su vrednovani tako da se 5,4,3,2,1 odnose na pozitivne odgovore, dok se 1,2,3,4,5 odnose na negativne odgovore. Svakoj se grupi ovaj upitnik daje kao instrument za pred-testiranje i post-testiranje, a na raspolaganju imaju 30 minuta za njegovo popunjavanje.

Ljestvica stavova o istraživačkom učenju (LjSIU)

Primijenjena je trostupanjska Likertova ljestvica (ukupno 25 čestica) da bi se utvrdilo što ispitanici misle o istraživačkom učenju i T dijagramu, a konstruirali su je Samancı i Bozkurt (2010). Čestice u njoj su podijeljene u dvije kategorije: (1) utjecaj T dijagrama na razvijanje vještina potrebnih za znanstveno-istraživački rad i (2) vrednovanje okruženja u kojem se provodi istraživačko učenje pomoću T dijagrama. Utvrđeni Cronbach koeficijent pouzdanosti iznosio je $\alpha = .73$

Format intervjua o T-dijagramu korišten u istraživačkoj metodi

Polustrukturirani intervju primjenjuje se da bi se utvrdilo što ispitanici misle o T dijagramu koji se koristi u istraživačkoj nastavi. Postavljena su im pitanja otvorenog tipa, a to su:

1. Koje su prednosti T dijagrama u odnosu na tradicionalno laboratorijsko izvješće?
2. Koji su nedostaci T dijagrama u odnosu na tradicionalno laboratorijsko izvješće?
3. Koji dijelovi T dijagrama nisu potrebni po Vašem mišljenju?

Analiza podataka

U ovom je istraživanju korišten t-test za neovisne grupe da bi se vidjelo postoji li razlika u stavovima o znanstveno-tehnološkom kolegiju između članova eksperimentalne grupe s istraživačkom nastavom i kontrolne grupe s tradicionalnim pristupom nastavi. Razmotrena je značajna razlika u 95% frekvencija pouzdanosti između rezultata eksperimentalne i kontrolne grupe s obzirom na ovisne varijable.

Kao rezultat analize, dalje se razmatra jesu li grupe ekvivalentne ili nisu, polazeći od aritmetičke sredine (X), standardne devijacije (SD), t-vrijednosti i razina značajnosti (p).

Konstruirane su tablice postotka (%) i frekvencija (f) za distribuciju odabranih odgovora pri analizi ljestvice stavova o istraživačkoj nastavi.

Polazeći od sadržajne analize koja je potrebna za vrednovanje intervjua o T dijagramu u istraživačkoj nastavi, utvrđeno je što ispitanici misle o postavljenim pitanjima i konstruirane su tablice postotaka i frekvencija.

Rezultati i komentari

Pod prvim se problemom u istraživanju najprije razmatra razlika u stavovima ispitanika poučavanih istraživačkom metodom i tradicionalno poučavanih ispitanika. Razlika između eksperimentalne i kontrolne grupe u rezultatima pred-testiranja u odnosu na LjSZTL prikazana je u tablici 2.

Tablica 2.

Kada se pogleda tablica 2 vidi se da nema razlike u razini značajnosti između rezultata pred-testiranja ispitanika u eksperimentalnoj i kontrolnoj grupi (t(64)= ,835, p>0,05). Nepostojanje spomenute razlike između eksperimentalne i kontrolne grupe (LjSZTL ljestvica) prije provedbe eksperimentalnog istraživanja pokazuje da su grupe jednake po svojim stavovima.

Tablica 3.

Prema podacima u tablici 3, prosjek rezultata postignutih u eksperimentalnoj grupi veći je poslije provedbe eksperimentalnog istraživanja. Razlika između eksperimentalne i kontrolne grupe statistički je značajna (t(64)=3,523, p<0,005), što se može pripisati neovisnoj varijabli, to jest metodi. U tom je kontekstu istraživačka nastava pozitivno utjecala na stavove ispitanika o znanstveno-istraživačkom laboratoriju.

U drugom se dijelu istraživačkog problema nastojalo odrediti koje stavove o istraživačkom pristupu učenju imaju članovi eksperimentalne grupe. Frekvencije i postotci koji se odnose na dimenziju T dijagrama pomoću koje se mjere rezultati stavova nalaze se u tablici 4.

Tablica 4.

Kada pogledamo "TD nam omogućuje usvojiti vještinu preispitivanja koncepata, događaja i pojava za razliku od sličnih eksperimenata kao što je "recept", vidimo da je to čestica oko koje su se ispitanici najviše složili (90,0%). Također, s iznimkom "TD omogućuje primjenu onoga što učimo u životu", oko ostalih čestica zabilježen je veliki postotak slaganja, između 20% i 90,9%. U tom se smislu može reći da su stavovi ispitanika o T dijagramu pozitivni.

Podaci za drugu pod-ljestvicu koji pripadaju ljestvici sa stavovima eksperimentalne grupe o istraživačkoj metodi prikazani su u tablici 5.

Tablica 5.

U tablici 5 možemo vidjeti da je najveće slaganje zabilježeno u vezi sa česticom "IU stvara učinkovito i aktivno nastavno okruženje" (90,9%). Najmanje je bilo slaganja oko čestice "IU nam omogućuje dobiti veće ocjene" (39,4%). Možemo reći da su stavovi ispitanika općenito pozitivni, a njihov postotak varira između 39,4 i 90,9.

Stavovima o T dijagramu, koji se koristi u istraživačkoj nastavi, nastojao se definirati treći dio istraživačkog problema. Mišljenja ispitanika o „prednostima T dijagrama u odnosu na tradicionalno laboratorijsko izvješće" te njihovi postotci i frekvencije navedeni su u tablici 6.

Tablica 6.

U tablici 6 ispitanici su izrazili mišljenje o prednostima T dijagrama, pozivajući se osobito na ove čestice: "razvija vještinu provedbe istraživačkog procesa, eksperimenti se prenose u svakodnevni život i omogućuje nam spoznati uobičajeni postupak".

Osim toga, tom su se prigodom tri ispitanika osobito referirala na česticu "njegove se varijable mogu kontrolirati", dok su dva ispitanika odabrala česticu "smanjuje broj eksperimentalnih pogrešaka."

Mišljenja ispitanika o nedostatcima T dijagrama u usporedbi s tradicionalnim laboratorijskim izvješćem navedena su u tablici 7.

Tablica 7.

Kada pogledamo tablicu 7, vidimo da se navode mišljenja o nedostacima T dijagrama u odnosu na tradicionalno laboratorijsko izvješće, kao što su: "njegova primjena je vremenski zahtjevna", "sadrži mnogo pojedinosti", "dosadan je" i "teško ga je primijeniti u praksi". Najmanje su navođena mišljenja "zahtijeva veliku pažnju" i "ne može se primijeniti na svakoj razini".

Ono što ispitanici smatraju nepotrebnim nalazi se u tablici 8.

Tablica 8.

Prema tablici 8, četiri su ispitanika navela da je čestica "prethodno znanje" nepotrebna, tri ispitanika smatraju da je to čestica "moguće eksperimentalne pogreške", a tri su ispitanika za tu potrebu odabrala česticu "fiksna varijabla". U tom su kontekstu neke od čestica povezanih s T dijagramom procijenjene nepotrebnim iako s niskim postotkom (12%, 9%).

Rezultati i zaključci

Kada je riječ o prvom dijelu istraživačkog problema, vidi se da istraživačko učenje – u usporedbi s tradicionalnim učenjem – čini značajnu, pozitivnu razliku u odnosu na stavove koje o laboratoriju za znanstveno-istraživački rad imaju budući nastavnici primarnog obrazovanja. Osim toga, spomenuti rezultat odgovara istraživanjima koja su u literaturi opisali Shymansky i sur. (1983), Kyle i sur. (1985), Germann (1994), Freedman (1997) i Orcutt (1997). Suchman (1968) predlaže definiciju: „Istraživanje je prije sama znanost nego znanstvena metoda" (citirano u Zion i sur., 2004, str. 728). Dakle, proces istraživačkog učenja omogućuje nam da tumačimo znanost i budemo aktivni, što nužno odgovara prirodi znanosti. Nastavni proces – aktivnosti u laboratoriju – utječe na stavove studenata. Utjecao je izravno na stavove ispitanika kroz njihovo aktivno sudjelovanje u nastavi i iznošenje ideja. Prema Wallace (1997), istraživačko učenje potpuno zadire u koncepte, vrijednosti, obrazovnu praksu i uvjerenja temeljena na stavovima koje studenti razvijaju dok se aktivno bave znanstvenim proučavanjem.

Kada pogledamo stavove o istraživačkoj nastavi u sklopu drugog dijela problema, vidimo da je postotak frekventnosti stavova budućih nastavnika o T dijagramu i spomenutoj metodi visok, 20 i 90,9%. U tom kontekstu primjećujemo da je ta metoda imala pozitivan učinak na ispitanike, te da su osobito čestice „omogućuje aktivno učenje", ,,provjerava vještinu propitivanja" i ,,uspostavlja uzročno-posljedični odnos" zabilježile visok postotak preferencije. Prema Wallace (1997), istraživačko učenje predstavlja niz koncepata, vrijednosti, obrazovnih praksi i uvjerenja zasnovanih na stavovima koje su studenti razvili dok su aktivno provodili istraživanje. Llewellyn (2002) smatra da istraživanje studentima omogućuje da se samostalno suoče s nekim problemom i pronađu njegovo rješenje. Kada ih se poučava o metodama i ciljevima istraživanja, dolaze do rezultata i vrednuju ih tako što na nove probleme primjenjuju vlastito mišljenje i uvjerenja. Prema Chiappetta i sur. (1998), istraživanje se koristi – u nastavi prirodoslovlja – kao aktivni proces koji obuhvaća znanstveno razmišljanje, postavljanje pitanja i strukturiranje znanja (citirano u Domjan, 2003). Također, izravno utječe na buduće nastavnike da zauzmu pozitivan stav o istraživačkom učenju, a rezultati istraživanja Germann (1994) i Freedman (1997) idu u prilog tome.

Kada je riječ o rezultatima ovog istraživanja s obzirom na prednosti korištenja T dijagrama, ispitanici su spomenuli sljedeće čestice: „eksperimenti se prenose u svakodnevni život", „omogućuje da se nauči ustaljeni/uobičajeni postupak" i „razvija vještinu provedbe znanstvenog procesa". Također se spominju čestice „potiče mišljenje i „omogućuje trajno usvajanje znanja". Nastava prirodoslovlja temeljena na istraživačkom pristupu učenju studentima je najprihvatljivija zbog donošenja općih zaključaka s polazištem u osobnom iskustvu. Studenti razvijaju vještine potrebne za korištenje raspoloživog znanja tako da se njima mogu koristiti tijekom života, nakon završenog formalnog obrazovanja (Plowright i Watkins, 2004). T dijagram je stoga važan za usvajanje vještina „aktivnog razmišljanja za vrijeme procesa" i „pamćenje". Prema Wilke i Straits (2005), istraživačka nastava upozorava na važne varijable i onemogućuje pogrešno razumijevanje jer se odgovori strukturiraju umjesto da se daju jednostavne definicije. Dakle, T dijagram – proces izvješćivanja o istraživačkom učenju – strukturiran je tako da uzima u obzir kontrolu varijabli, pojašnjenje koncepata te interaktivnost na više razina.

Kada pogledamo nedostatke T dijagrama koje su budući nastavnici navodili, vidimo da oni proizlaze iz njegove dugotrajne, detaljne i zahtjevne primjene. Büyükkaragöz i Çivi, (1999) također ističu da istraživačko učenje djeluje učinkovito na razvijanje složenijih mentalnih procesa i kognitivnih ponašanja, kao što su: primjena, analiza, sinteza i evaluacija. Prije nego što se pređe na metodu potrebnu za postizanje zahtjevnijih ciljeva, trebalo bi dostići barem razinu razumijevanja.

Ako im praktičari ne mogu pomoći „da nešto nauče kako bi to razumjeli", onda je normalno da učenici imaju poteškoće u procesu učenja. Studenti smatraju da bi „zašto" i „novo znanje" trebalo ukloniti iz T dijagrama, a razmotriti sljedeće: Praktičari ne uspijevaju potpuno objasniti kako primijeniti novo znanje da bi se znali rješavati različiti problemi i teško im je uspostaviti odnos.

S obzirom na rezultate istraživanja daju se sljedeći prijedlozi:

1. da bi obrazovali pojedince koji se znaju koristiti laboratorijem za znanstveno-istraživački rad, nastavnici bi trebali primjenjivati kreativne i zanimljive metode, a ne tradicionalne s nastavnikom u središtu nastavnog procesa;
2. nastavnici trebaju dobro iskoristiti vrijeme kada koriste istraživačku metodu u nastavi, stoga trebaju doći u školu pripremljeni i vrlo pažljivo planirati nastavni sat.
3. učenici na početku moraju biti informirani o T dijagramu koji se može koristiti u procesu izvješćivanja i trebaju izbjegavati usmjerenost na nepotrebne pojedinosti.
4. učenicima bi trebalo omogućiti da, na razini razumijevanja, usvoje potrebno predznanje i vještine kako im ne bi bilo teško kreirati T dijagram i koristiti se njime.
5. moguće je razmotriti učinak vještina potrebnih za istraživačko učenje i samoučenje.
6. ovo je istraživanje provedeno s budućim učiteljima, ali može se primijeniti na buduće nastavnike prirodoslovlja ili nastavnike u sekundarnom obrazovanju.